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On Acanthopholis platypus (*Seeley*), *a Pachypod from the Cambridge Upper Greensand.* By Harry G. Seeley, F.G.S., St. John's College, Cambridge.

[Plate VII.]

There is no period in English geology in which the rocks themselves have not furnished evidence of the proximity of land to what are now our coasts. Occasionally they prove the present land and the past lands to have in part included each other; and in between these periods of similar altitude the depression is rarely if ever so profound or wide-spread as to remove the land to a distance too great to be measured approximately in miles by the evidence from the distribution of its detritus. But when the stratigraphic teaching becomes difficult to read or unravel in reasoning, then the fossils come to hand, in a rough way cut the knot that could not be untied, and invest the subject with new interest in the distribution of life; for sea-life, land-life, and river-life are in the main so different from each other, that they give evidence of the extent of strata and of the causes which limited them which are second only in usefulness to the lithological and petrologic facts. Among such obscure problems, but for its fossils, would have been the history of the Cambridge Upper Greensand—a mere junction-bed between the Gault and the Chalk; but the fossil fruits, the sea-birds allied to *Colymbus* and the penguins, the flocks of aërial quadrupeds (Ornithosaurs), the schools of Emydian Chelonians, and, lastly, the land-quadruped *Acanthopholis*, point to their home in a not distant country, of which the other deposits between the Gault and Chalk to the south and north help to tell the whereabouts and history.

Acanthopholis is a genus of Pachypod animals instituted by Professor Huxley, in the 'Geological Magazine' for 1867, for a Scelidosaurian from the chalk-marl of Folkestone—Scelidosaurian rather than Dinosaurian, because the three families typified by *Scelidosaurus*, *Iguanodon*, and *Megalosaurus* seem to show affinities so various as to make it doubtful whether *Scelidosaurus* can be included in the same order with the Megalosaurs.

The genus has occurred sparingly for the last ten years in the Cambridge Upper Greensand, but is rarely represented by any parts except foot-bones, caudal and dorsal vertebræ, and scutes. These fossils indicate, by the difference in the form of the bones, three species, which varied in size from that of a sheep to that of a small ox. They had the tail shorter and smaller than is usual with Iguanodonts, were heavily striped with dermal armour, had large limbs, which do not appear to have been so unequal or so long as among the Iguanodonts; and the animal had not a large head.

To the largest species I have given the name *Acanthopholis platypus*; but, like too many of the osseous relics of the Cambridge Greensand, the remains indicate but a small portion of the animal—in this case the metatarsal bones of one foot, a worn phalange, and six caudal vertebræ. And it is right to remark that the association of these bones as remains of one individual rests on no other evidence than their having been disinterred together in the same pit (at Bottisham), and no other remains of a like kind having occurred near them. And, after study of the specimens and comparison of them with other remains of *Acanthopholis*, I see no reason to doubt the association being natural; and they make known a form of foot-bones and vertebræ of which no other example is known. No materials are available for judging whether this species is identical with or distinct from Prof. Huxley's type species, *A. horridus*, since no teeth have come under my notice which can be referred to the genus and compared with the premolar or incisor teeth figured by Prof. Huxley; and the scutes which that gentleman figures, and the vertebræ described in his memoir, are remains which afford no data for *specific* comparison. I may here express a conviction that in dealing with fossil remains of large animals, the anxiety of naturalists to allow every possible margin of variability to their species rather than risk the creation of a doubtful type, has led, with some orders and among Europeans, to the retaining of groups of Linnean magnitude, where the species are really genera; and thus false conclusions result as to the want of stability of character in extinct types, as to the fewness of genera, and

the accuracy of the method of research. It therefore seems desirable that fossil groups should be comparable in magnitude with the genera and species of true (*i. e.* living) Reptilia.

Probably the Folkestone fossil and these from Cambridge occur upon the same horizon; for the Cambridge animals are usually from the upper portion of the phosphatic stratum, and are rarely mineralized with phosphates, while the *Acanthopholis horridus*, according to Mr. Etheridge *, is from the Chalk-marl, about 8 feet above the Upper Greensand; and almost all the marine species found in the bed, except Ammonites and some of the Echinoderms, are also fossils of the Cambridge Greensand.

The English Dinosauroids of which the foot-bones have hitherto been figured are referred to *Hylæosaurus*, *Iguanodon*, *Scelidosaurus*, and *Hypsilophodon*. The metatarsus in *Hylæosaurus* is made of three somewhat slender and greatly elongated bones †. In *Iguanodon* there are three principal metatarsal bones, which are less elongated and relatively much stouter than in the specimen referred to *Hylæosaurus*, while there is also a rudimentary slender fourth metatarsal ‡. In *Scelidosaurus* there are four moderately elongated metatarsals, of which the first is conspicuously short; and there is also, according to Professor Owen, a slender styliform rudiment of a fifth metatarsal, which is adherent to the proximal end of the fourth §; while in the skeleton which Professor Huxley refers to *Hypsilophodon* (Quart. Journ. Geol. Soc. Feb. 1870) the animal is remarked upon as possessing certainly four, and perhaps also a slender fifth metatarsal bone, which, from Prof. Owen's figure ||, appear to be about as long as 2½ centrums of dorsal vertebræ, and rather more slender than the metatarsus of *Scelidosaurus*. When, therefore, the foot of *Acanthopholis* was found to consist of five well-developed bones, of which the fifth appears well capable of carrying phalanges, and the first is singularly massive, the animal was invested with platypodial interest, as probably showing a character new in the order, and offering a new point of affinity.

At the time in which Prof. Owen wrote (1857) some doubt hung over the determination of the terminal segments of the fore and hind limbs; and this doubt is not to be neglected in interpreting the present specimens, notwithstanding the researches of Leidy, Cope, and Huxley on the proportions of the Dinosaurian limbs.

* Geol. Mag. 1867, vol. iv. p. 68.

† Wealden Rept. 1857, part 4, pl. xi.

‡ *Loc. cit.* pls. i.–iii.

§ Oolitic Rept. 1862, part 2, p. 17, pl. x.

|| Wealden Dinos. 1854, pt. 2. pl. i.

The form of the bones, considered by itself and in relation to the other known fossil types, as well as the osteology of recent crocodiles and lizards, would have led me to suspect the metapodium to consist of the metacarpal bones; yet the enormous size of the foot-bones and small size of the caudal vertebræ, and the fact, demonstrated by all other fossils, that the fore foot is smaller than the hind foot, make it *probable* that the inferences from comparison have in this case no importance, and that the bones are metatarsal. From the shape of the bones I should infer that the distal ends of the metatarsals did not approximate towards each other closely, and that the three inner bones and two outer bones were fasciculated.

Another difficulty in the restoration of the foot will occur to the student of Prof. Owen's writings, from the way in which the foot of *Iguanodon* is interpreted in the Palæontographical Monograph for 1857 (Wealden Rept. pt. 4). Here the Professor explains the rudimentary metapodial bone as the first or innermost toe. This interpretation is so much opposed to the analogy of recent crocodiles and lizards and fossil Pachypods, that I venture to suggest that the digit which Prof. Owen has named the fourth is really the first, and that which is named innermost is really outermost; and consequently the bones, instead of belonging to the right foot, would belong to the left. And to account for this inversion we must believe that, in extracting the fossil or by some subsequent accident, the phalanges of the first and third digits came to occupy each other's places, which would be more credible than the interpretation which makes the first Dinosaurian metatarsal a mere rudiment. Moreover the proximal angles of the bones overlap each other, as in the recent Reptilia; only, if Prof. Owen's interpretation were accepted, they would overlap in a reverse direction to that seen in Reptiles or Pachypods, the angles being directed *inward*, according to the figure. This alone seems to me sufficient evidence of the error; and so I would suggest to all possessors of casts of Mr. Beckles's fossil to retranspose the phalanges of the first and third digits, the present arrangement being as much in defiance of osteological experience as any angel or mermaid. It may not be out of place if I remark that no corroborative evidence has yet been published that the fossil foot referred by Prof. Owen to *Iguanodon* really belongs to that genus. The passage "Not far from where the foot-bones were found, the femur, tibia, and fibula of the same *Iguanodon* were extracted—a circumstance which adds to the probability of their belonging to the same limb" is obviously meant to beg the question of the determination, and is not put in as proof. Prof. Owen also speculates that if the claw of the

rudimental digit were fully grown, it would probably show the features "which characterize the claw-phalanx which has been mistaken for the horn of *Iguanodon*." That horn has been harped upon so steadily, that I will venture to wind it once more. First, then, it is manifest that the determination quoted is as pure a dream as a midsummer night could invent. But in 1854 (Wealden Dinosauria, part 2) the illustrious author devoted many pages to a consideration upon this horn; and there, too, the bone which Dr. Mantell so confidently exalted is degraded to being the support for an Iguanodon's toe-nail, seemingly because Dr. Mantell had named it a horn. I do not wish to defend Dr. Mantell, though I think that his scientific instinct led to a conclusion which was philosophically good; nor do I wish to underrate the spirit of Prof. Owen's protest that *Iguanodon* can by no means be inferred to have had a horn because such a structure is found in *Iguana*. Even if wrong in this particular case, it was important for the progress of science that uniformitarianism should not creep unopposed into comparative anatomy. But in the elucidation of the truth it is desirable not to neglect facts; and from the time when Prof. Owen observed that "the mutilated basal surface in no wise militates against the supposition of the conical bone having been the terminal unsymmetrical ungual phalanx," &c. &c., to this day no foot has been found containing a bone which resembles it; no indubitable terminal phalange resembles it closely; while it is closely matched by Dinosaurian dermal armour, especially that of *Scelidosaurus*. That it was a nasal horn is highly improbable; but that it is a dermal spine of some Dinosaur seems almost certain after a comparison of the specimens. And if any one, thirty years ago, had had the opportunities which students have now in the national collection, I venture to think that Dr. Mantell's horn would never have been made to claw the dust.

The bones of the metapodium of *Acanthopholis*, placed together, measure over their proximal ends 9 inches from side to side, while the middle bone is about 6 inches long; they are well expanded at the proximal and distal ends; and the shaft becomes more slender from the first to the fourth. The proximal ends of all are flattened, transversely truncated, and slightly twisted outward; while the distal ends are rounded from above downward, and approximate to the usual pulley-shaped articulation. The bones are all slightly worn, and have suffered a little abrasion at their articular surfaces.

The *first* bone is short and strong. The flat *proximal articulation* is shaped in outline like half of a wide pear, with the convex surface external, the vertical cut surface internal, and

the compressed apex upward. As preserved, this surface measures

In height.................. $3\frac{3}{4}$ inches.
From side to side where widest $1\frac{1}{8}$ inch.

The *inner* flattened vertical surface of the bone is somewhat triangular in outline; its moderately concave superior margin and its more concave inferior margin approximating towards the distal end, but remaining separated by a convex expanded outline of the distal articulation. The whole inner surface is gently concave from front to back: at the back, where $3\frac{3}{4}$ inches deep, it is flat; in front, behind the articulation, where an inch deep, it is convex from above downward. The *external* surface is convex and oblique from above downward proximally; but at the distal end, by the form of the articulation, it becomes angulated, so that the external slightly convex part is short and vertical, and the superior convex part hangs a little to the inner surface. In length this surface is gently concave. The extreme length of the bone as preserved is, on the inner side, nearly 4 inches. The *distal articular* surface is somewhat abraded. It is in outline concave below, higher on the outside, compressed on the inside, and convex above, so as to be ear-shaped. As preserved, it measures $2\frac{3}{4}$ inches from side to side, and nearly 2 inches high at the outer part. The surface is depressed in the middle towards the under part, where it terminates in an oblique transverse thickening: it is not parallel with the proximal surface, but inclined to it so as to look externally away from the second bone. The *under* surface is rhomboid, half as long again as wide, wider in front than behind, concave in length, and slightly convex from side to side.

Externally the bone shows a few small nutritive foramina; and in a corresponding bone from another species (marked, in the Woodwardian Museum, J. c. 25) foramina are conspicuously numerous on both the proximal and distal ends, though, probably owing to the state of its preservation, no trace of them is seen in the specimen now described.

The *second* bone is strong, longer than the first, and less stout; it is $5\frac{3}{4}$ inches long. The proximal articulation is four-sided, with the sides nearly parallel; it is oblique to the distal articulation, inclining towards the third metapodial bone; it measures $4\frac{1}{4}$ inches in height, and about 2 inches from side to side at the proximal and distal ends, and $1\frac{3}{4}$ inch from side to side in the middle. The long outline towards the first bone is straight, that towards the third bone is moderately concave; the superior outline is slightly convex, and the inferior outline

slightly concave. The whole surface seems to be laterally oblique to the shaft of the bone, being inclined towards metapodial bone no. 1; it is not so flat as the corresponding surface in no. 1, being slightly convex both in breadth and length.

The bone contracts between the proximal and distal articular ends, and in the middle of the shaft measures $1\frac{1}{4}$ inch from side to side, and $1\frac{5}{8}$ inch from above downward behind the distal articulation. The lateral and upper and under surfaces are all concave in length. The lateral side towards bone 1 is flat, vertical at the two ends, and very slightly convex in the middle. The lateral side towards bone 3 is concave vertically at the proximal end, flat in the middle, where it approximates on the under surface towards the other lateral side, and flat at the side of the distal articulation; all these parts are in different planes. The superior surface is convex; it is obliquely inclined towards bone 1 at the proximal end, and less inclined towards bone 3 at the distal end. The under surface contracts so as to measure about $\frac{3}{4}$ of an inch from side to side in the middle; at the two ends it is concave from side to side. The distal end is subreniform in outline, being convex above, concave below, and flattened or slightly convex at the sides. It measures $2\frac{1}{2}$ inches from side to side, and more than 2 inches from above downward; it is regularly convex from above downward; and toward the under half a median depression appears and continues increasing in concavity. The articulation does not make quite a right angle with the shaft, being a little inclined towards the first metapodial bone.

In the *third* bone the proximal and distal ends are less expanded than in the second bone, so that its aspect is more slender; it measures $6\frac{1}{4}$ inches in length. The proximal articulation is more quadrate than in the second bone, measuring about 2 inches from side to side, and $2\frac{3}{4}$ inches from above downward; it is set on to the shaft with an obliquity like that seen in the second bone, and similarly has the two pairs of sides parallel and the surface convex. The side towards the second bone is very convex, an inflation running down the middle of the side, and dying away towards the condyle of the distal articulation. Proximally the side of the bone looks as though slightly compressed in fossilization; distally the side is flat. All the sides are concave in length, the upper one least so. The side towards bone 4 is smooth and flat, and inclines inferiorly towards its opposite side, so as only to be divided from it below by a rounded ridge. The upper surface is better defined than in the other bones described; it is concave from side to side behind, and convex from side to side in front. The shaft measures from side to side in the middle $1\frac{1}{4}$ inch,

from above downward $1\frac{5}{8}$ inch. The distal end is ovately oblong, convex from above downward, whereas in the other bones the condyles become more marked; as in those bones, the median depression on this surface is only noticeable towards the under part; and, as in the previous cases, the articular surface is *slightly* oblique to the shaft laterally, inclining towards the second bone. The surface measures $2\frac{1}{2}$ inches wide by $1\frac{3}{4}$ inch from above downward.

The *fourth* bone is not well preserved, both articular ends being rubbed. The bone is gradationally more slender than that last described, and has proportionally smaller articular ends; it measures, as preserved, $5\frac{5}{8}$ inches in length. The proximal articular end is triangular, measuring $1\frac{3}{4}$ inch along the horizontal slightly concave superior surface, $2\frac{1}{2}$ inches along the flattened side towards bone 3, and $2\frac{7}{8}$ inches along the flat side towards bone 5. The two sides meet below in a rounded ridge proximally. The side towards bone 3 is gently convex from above downward; the side towards bone 5 is flat from above downward proximally, convex from above downward distally. All the sides are concave in length, the underside and that towards bone 5 most so, the superior surface least so. In the middle the shaft measures less than an inch from side to side, $1\frac{1}{4}$ inch from above downward, as in previously described bones. Towards the distal end the bone from above downward steadily contracts in depth up to the enlargement made by the condyles of the articulation; and, as in the other bones, the distal end expands from side to side, only more noticeably. The distal articular surface is like those already described, and oblong, with the sides convex and the under surface slightly concave; it measures more than 2 inches from side to side, and nearly $1\frac{1}{2}$ inch from above downward.

The *fifth* bone is badly preserved at its articular ends; as preserved, it is $5\frac{1}{2}$ inches long; it is in form much compressed from side to side, and much expanded from above downward at the proximal articulation. It is difficult to give the form of this elongated area; but its outline is flat on the inside of the bone and convex on its exterior side; it measures $3\frac{1}{2}$ inches from above downward, and $1\frac{1}{4}$ inch from side to side, but does not narrow inferiorly as it does superiorly, because the inner angle is inflected so as to support the under part of bone 4. The underside of the bone is very concave from back to front, and well rounded from side to side; but the side-to-side measurement decreases towards the distal end. The inner side, as remarked, is flat, and terminates above in a sharp ridge, which extends down more than two-thirds the length of the

bone, and then abruptly terminates. The external side is nearly straight between the articulations, and convex from above downward; but towards the distal end an inflation appears towards the upper part, so as to make it approximate in outline to a vertically elongated oval. The least measurements of the shaft behind the distal articulation are less than 1⅛ inch from side to side, and less than 1½ inch from above downward. Beyond this the distal articulation expands but little, measuring, as preserved, 2 inches from above downward, and one inch from side to side; so that while the distal articulation in the other bones is transversely oblong, in this fifth digit it is vertically oblong. It is an inference, perhaps not unworthy of consideration, that since the deposit yields two kinds of claws presumably Dinosaurian, one depressed as in Chelonians, the other compressed as in Lizards, the former may have belonged to the first four digits, and the latter to the fifth.

In size and form of the bones this metapodium suggests comparison with the pachypod mammals, and most conspicuously, by the presence of five digits, with the elephant, in which the metapodial bones are equally large. But in the elephant the bones of the fore foot are larger than those of the hind foot, contrary to the rule with Dinosauria. An elephant would similarly have had the proximal ends of the bones transversely truncated; the proximal end would similarly have had a great depth from front to back, and have preserved the same width from side to side. The form of the distal end would have been the same, though the slight mesial depression of that articulation in the fossil would have been represented by a slight mesial elevation in the mammal. The bones would not have obliquely overlapped at the proximal end in the elephant; and in that animal the large massive bone would have been the fifth, and not the first as I have named it, and the shafts of the other bones would not so steadily decrease in size. In *Rhinoceros* and *Hippopotamus* the bones conspicuously have a tendency for the inner to overlap the outer at the proximal ends as in the fossil.

Among birds, not even among fœtal birds, so far as known to me, is there any structure in fore or hind limb which can be compared with this metapodium of *Acanthopholis*. Coming to crocodiles, there is a similar gradational decrease in size of the shaft in bones 1 to 4 in the hind limb; but then in crocodiles the fifth bone is wanting, and the bones are out of all proportion too long. In the fore limb, however, there are five digits, and the proportions of the bones match much better what is seen in the fossil; the angle, however, which the

proximal end of the bone makes with the distal end is greater in crocodiles than in *Acanthopholis*, and the fifth bone is shorter and of different shape. In the Nilotic *Monitor* the metapodium includes five elements in both front and back limbs, but only in the front limb is the fifth bone compressed at all as in the fossil; and in the hind limbs the bones are elongated as in the crocodile; and in neither limb is there a gradational decrease in the size of the shaft from within outward. Nor is there a nearer resemblance in *Uromastix*, *Stellio*, *Lacerta*, *Polychrous*, *Iguana*, *Draco*, or any of the typical lizards with which I am familiar.

Among the Emydian Chelonians, of numerous genera the metapodium similarly shows a gradational decrease in the size of the bones from the first to the fifth, with similar proportions for each bone, a similar overlap of the proximal ends, and similarly shaped articular surfaces.

Among frogs the bones gradationally *increase* from the first to the fifth; but the overlap of the proximal ends is usually discernible, so that the right and left feet could not be confounded.

From these comparisons it would seem that the only living animals which throw light on the structure of the foot in *Acanthopholis* are the Elephant, Emydians, and Crocodiles. Since the fossil bones have no epiphyses, have the reptilian form of distal articulation, and have the bones arranged in their relation to each other and to the limb in a markedly reptilian way, it seems probable that the resemblances to the elephant, close and curious as they are, must be classed as a functional modification, and not as a mark of organic approximation of the Dinosauria towards the Mammalia, though with our present imperfect knowledge it may not be easy to estimate the influence of such a pachypodial function in inducing differentiation of the higher vital tissues. The comparison, then, is limited to Emydians and Crocodiles; and, in view of the pachypodial function of the Emydian limb, it will not be surprising if that type is found to be the nearer to *Acanthopholis*: nevertheless the resemblance of the fore foot of the crocodile is such as might well make any one pause in doubting its crocodilian affinity; for in a case where the functions of the parts were presumably dissimilar and the structural resemblance not unlike in both, the affinity is presumably strongest genetically where the functions of the parts are different. In this case such a view would make the crocodilian resemblance at least as important as the resemblance to Chelonians. Yet as the Dinosaurian type would, from our present palæontological knowledge, seem to be at least as old as the recent monimostylican Reptilia, the resemblance throws no

light on the Dinosaurian affinities attributable to direct descent, but only demonstrates in the living reptiles collateral divergences from fossil types which have still to be discovered.

But one phalange was found with the metapodium; it, too, recalls the phalange of an elephant, being like the second in the compression of the distal articulation from above downward, and in the shortness of the bone from front to back. As preserved, the proximal articulation measures 1⅝ inch from side to side, while the distal articulation measures 1⅞ inch from side to side. The posterior articulation is transversely ovate, slightly concave, and, as preserved, measures an inch from above downward in the middle; but both articulations are worn; the distal articulation does not measure ¾ of an inch from above downward. The bone is more compressed on its right side than on the left; and the right measures less from front to back than the left side, the right side being 1¼ inch, and the left about an eighth of an inch more. Among reptiles only Chelonians have phalanges of this shape.

The vertebræ associated with these foot-bones are all caudal. The earliest in sequence of the series preserved may be regarded as one of the earlier caudals; for relatively to the others the centrum is shorter and deeper, the transverse process and neural arch (which is not preserved) had a stronger attachment, and the facets for the chevron bone on the hinder margin were wider apart and larger. The anterior articulation is the more concave of the two, and has a central boss similar to that seen in Pliosaurs and certain Plesiosaurs. The outline of the posterior end of the centrum is a depressed pentagon, measuring about 2¼ inches from above, and more than 2½ from side to side where widest. From front to back the centrum measures 2 inches.

The second bone of the series is in much better preservation: it measures 2¼ inches in length; and the posterior articulation is not so much larger than the anterior articulation. The neural arch is not preserved; but the broken attachment of the neurapophysis is lenticular, about an inch long and a ¼ of an inch wide, and placed equally distant from the anterior and posterior margins. The space between the neurapophyses is concave and a little excavated. External to the neural arch on the shoulder of the centrum on each side is a prominent ridge, which arises about ⅝ of an inch from the anterior margin (where they are 1⅝ inch apart); they are prolonged horizontally backward, becoming rather more marked and slightly diverging; they make the lateral spaces both above and below them to be concave. Rather lower below this pair of ridges than they are below the neural arch is a second horizontal

pair; they do not arise quite so far forward, but extend back, widening and thickening almost to the posterior articular surface; they make the widest part of the centrum. Below these ridges the sides of the centrum converge inferiorly to the hypapophysial ridges; between these limits the depth of the side is $1\frac{1}{2}$ inch; above the middle of this area is a faint horizontal ridge which divides it into two unequal parts and gives it a convex aspect. The narrow under surface is limited by the two faint hypapophysial ridges, which slightly approximate in the middle and diverge towards the two ends, terminating posteriorly in the oblique facet which is confluent with the posterior articulation. The posterior side is unequally six-sided, in every case a long side having a short side opposite to it, there being a long superior margin and a short inferior margin, two short sides above and two long sides below. Both articulations are rather conspicuously concave.

In the third vertebra the centrum is equally long, but is much smaller, the posterior articulation measuring more than $1\frac{1}{2}$ inch from above downward, and nearly 2 inches from side to side; while in the second vertebra the similar surface measures $1\frac{3}{4}$ inch from above downward and $2\frac{1}{4}$ inches from side to side. In the third bone the first pair of ridges become stronger, the second become much fainter, and the obscure third ridge is now a well-marked tumid ridge: in consequence of these modifications the lateral spaces of the sides become more concave from above downward. The hypapophysial ridges have approximated much closer together, and become more elevated, especially in front, showing that the chevron bone now articulates with both the vertebræ between which it is placed; and there is a marked increase in the concavity of this under surface from front to back.

The fourth bone is badly preserved.

In the fifth vertebra the length of the centrum is 2 inches; but the depth of the posterior articulation, including the chevron surface, is $\frac{5}{16}$ inch, while its width from side to side is $1\frac{1}{2}$ inch; the lateral surfaces are markedly concave; and the whole bone looks like a substance contracted and withered. The first and second pairs of lateral ridges have disappeared; and the third ridge is now a strong elevated ridge, dividing the side into two equal parts, and at its terminations making the widest part of the articular ends. The hypapophysial ridges become parallel, rounder; and the whole under surface from back to front is deeply concave. The posterior articular surface is only slightly larger than the anterior end; and the facets for the chevron bones are nearly equal. The intervertebral cup is becoming less deep.

In the sixth bone the centrum is $1\frac{5}{8}$ inch long. The side

ridge has become depressed, and the side is rounded, so that the flattened articular end has an aspect of being a little compressed from side to side.

These vertebræ, if really belonging to the same individual as the foot-bones, would indicate a smaller and more mammal-like tail than that attributed to the other Dinosaurs. Judging from Prof. Owen's figures (Palæont. 1862), the early caudal vertebræ of *Scelidosaurus* have the centrum more obliquely inclined forward, a neural arch with a longer attachment, longer and stronger transverse processes placed more anteriorly, and an absence of ridges on the side of the centrum, which has the articular margin more thickened; but the absence of ridges from the centrum is the most marked character of *Scelidosaurus*, which distinguishes its caudal vertebræ from those of this animal.

The caudal vertebræ of *Hylæosaurus* have not been figured by Prof. Owen.

The caudal vertebræ of *Hypsilophodon*, so far as can be judged from Prof. Owen's figure (Palæont. 1854, pl. 1), appear to be not dissimilar, but have the transverse processes from the centrum more developed and placed *anteriorly* instead of posteriorly, while the articular margins of the centrum seem to be greatly developed. In *Iguanodon* (Palæont. 1854, pl. 9, and 1851, pl. 37) the resemblance to the centrum of *Acanthopholis* is much closer (supposing the figured determinations to be satisfactory), and the differences would seem to be chiefly in the proportions of the bones. Presuming that most of the Dinosaurian caudal vertebræ from the Potton Sands are to be referred to *Iguanodon*, it will be noticed that the centrum is more elongated than in *Acanthopholis*, and has but one ridge on the middle of the side of the centrum, while the basal surface is not so concave from front to back, nor the parts of the side so concave or convex respectively from above downward.

In *Hadrosaurus* the centrum, as figured by Leidy, appears to be much shorter from back to front, and not likely to be confounded with *Acanthopholis*.

On comparing the fossil with reptiles, the cup-and-ball articulation, the long attachment of the neural arch, and the strong transverse processes (not to mention the number of vertebræ) show the tail of lizards to be well distinguished from *Acanthopholis*. In *Chelydra* (*Emysaura*), where the Chelonian tail is long and has the vertebræ in some respects comparable, the centrum is opisthocœlian.

Among crocodiles the articular ends of the centrum are flattened instead of being concave, and the centrum differs in most of its details; but of all reptiles the crocodile is least unlike this Dinosaur, though no crocodilian vertebræ have the

centrum so short as the early caudals of *Acanthopholis*, and all differ in the neural arch, the transverse process, the absence of horizontal lateral ridges, and greater compression of the body of the centrum from side to side.

In birds the tail is not similar.

But among mammals of many kinds there is a closer approximation to the Dinosaurian tail in proportion, form, and detail of vertebræ than is seen in the crocodile, even the neural arch becoming singularly small in the Dinosaur. These mammalian resemblances, supposing them to be essential Dinosaurian structures, would tend to indicate a common parentage for Dinosaurs and Mammals in the ornithodelphian direction, and not that there were similar vital organs for the Mammalian and Dinosaurian types. And probably the time is near when the student of osteological synthesis, endeavouring to emulate the achievements of the astronomer predicting the orbits of new planets, will be able to characterize orders and perhaps whole classes of extinct and undiscovered animals from the evidence of their structures inherited in the types which survive.

EXPLANATION OF PLATE VII.

Fig. 1. Front view of the metapodium of *Acanthopholis platypus*.
Fig. 2. The proximal ends of the same metapodial bones.

These figures are half natural size, and from photographs by A. Nicholls, Cambridge.

I

II

R. Mintern lith.

Mintern Bros. imp.